The Effect of UV-B Lighting Supplementation in African Grey Parrots

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Vitamin D tightly regulates calcium metabolism in birds as in mammals; it decreases renal clearance and increases intestinal absorption of calcium. The metabolism of vitamin D is closely controlled by parathyroid hormone secreted from the parathyroid glands in response to low serum ionized calcium concentrations.

Birds acquire vitamin D_3 from a combination of endogenous synthesis and dietary supply. The natural synthesis of vitamin D_3 begins with the conversion of cholesterol to 7-dehydrocholesterol by isomerization. This reaction occurs in the featherless epithelial cells of the bird's skin and requires radiation in the 285-315 nm wavelength (ultraviolet [UV]-B) spectrum. Poultry have been shown to have 30 times more provitamin D on the featherless skin of the legs compared with the back, indicating the importance of this area for vitamin D metabolism. Only small amounts of provitamin D were found in preen gland oils in the same study. Poultry do not have a dietary requirement for vitamin D_3 if they are supplied with adequate UV-B radiation. If vitamin D3 is supplied in the diet, it can be absorbed with 60-70% efficiency in birds.

Vitamin D can be toxic, causing soft tissue calcification and renal failure if fed to excess. Some species of psittacine birds, such as macaws, seem more susceptible than others to clinical signs of vitamin D toxicosis. To prevent toxicity, dietary vitamin D is supplied as the inactive precursor, cholecalciferol, which requires metabolism by a two-stage hydroxylation process to become biologically active.

Failure to provide adequate light in the UV-B spectrum to poultry while feeding diets with low calcium or vitamin D_3 content will lead to a breakdown in vitamin D metabolism and, subsequently, clinical signs of hypocalcemia. Rickets is a common abnormality in commercial poultry reared with inadequate calcium, vitamin D_3 or light in the UV-B range. In commercial poultry flocks, the incidence of skeletal abnormalities is 1.72%. Hypocalcemic birds also show poor reproductive performance. In most situations with commercial poultry, there is a compromise between the amount of dietary vitamin D_3 administered (on the basis of economy and toxicity) and UV light supplementation provided for adequate vitamin D metabolism.

Hypocalcemia in captivity is a well-recognized syndrome in African grey parrots (*Psittacus erithacus*), although its etiology is still unconfirmed. Affected adult birds present clinically with a variety of neurological signs, ranging from slight ataxia to seizures, which respond to calcium or vitamin D_3 therapy. In juvenile grey parrots, osteodystrophy is a common presenting clinical sign (**Fig 1**). Radiographs of affected birds will show curvature of the long bones (**Fig 2**). Histopathology of the parathyroid glands and bone from osteodystrophic juvenile grey parrots suggests a diagnosis of nutritional secondary hyperparathyroidism (**Figs 3, 4**).

Although hypocalcemia is reported in other psittacine birds, it appears to be most prevalent in African grey parrots. It is possible that the syndrome could be due to either primary hypoparathyroidism or hyperparathyroidism secondary to inadequate husbandry. Captive grey parrots are usually fed seed-based diets containing low levels of calcium and vitamin D_3 with high levels of phosphorus. This would be expected to lead to a secondary nutritional

Resources at a Glance

- Elsec UV-B 743 monitor (IrLog Logger) - Littlemore Scientific Engineering, Oxford UK www.littlemore.com
- Phillips Flutone TLD/96S 58W fluorescent tubes www.phillips.com
- Harrison's High Potency Coarse - HBD International, Brentwood, TN www.harrisons birdfoods.com
- Tidymix seed - www.woodhatchparrots.co.uk/tidymix.htm

Fig 1. Severe osteodystrophy in a 4-week-old African grey parrot. Due to the severity of the skeletal changes, the bird was euthanized.

Fig 2. Radiograph of a 12-week-old parrot with typical radiographic signs of osteodystrophy.

Fig 3. Humerus from a bird with juvenile osteodystrophy. It was possible to bend and break the bone with minimal force.

Fig 4. Enlarged parathyroid gland from an African grey parrot with clinical signs of severe osteodystrophy. Histopathology revealed increased numbers of chief cells in the gland, consistent with hyperparathyroidism.

hyperparathyroidism but does not explain why grey parrots are more susceptible to hypocalcemia than other captive parrot species. These birds are indigenous to West Africa and live in open forest with low shade where they are exposed to high levels of UV light. South American species live below a dense tree canopy, which reduces their exposure to UV-B radiation. In captivity, parrots are usually kept indoors with limited access to UV light. This might suggest that African grey parrots require more UV light supplementation than other psittacine birds and may explain the increased susceptibility of this breed to hypocalcemia. Initial studies have shown that the provision of adequate UV light might be important for behavioral responses and, in particular, mating rituals in companion psittacine birds. Over 68% of psittacine birds have UV-reflective and fluorescent plumage, the former of which has been shown to have a significant effect in the selection of a mate in budgerigars. Bulbs providing UV-B radiation have recently been marketed in aviculture circles to encourage improved breeding performance. However, the role of UV-B radiation in the control of vitamin D metabolism has not been researched in psittacine birds.

The majority of captive reptiles require artificial lighting that emits radiation in the UV-B (315-285nm) spectrum. Failure to provide adequate lighting leads to inadequate calcium metabolism and subsequent metabolic bone disease, often with accompanying pathologic fractures. This condition may be difficult to treat, as the patient is often presented in an advanced clinical state, and animals usually succumb to secondary renal hyperparathyroidism. One might expect this to be the case as well in psittacine birds indigenous to countries with high UV light levels. However, artificial lighting has not traditionally been considered necessary for captive psittacine birds. The measure-

Fig 5. The view of the building housing the African grey parrots used in this study. The UV-B lights were positioned above each pair of African grey parrots in the study and turned on for 12 hours daily.

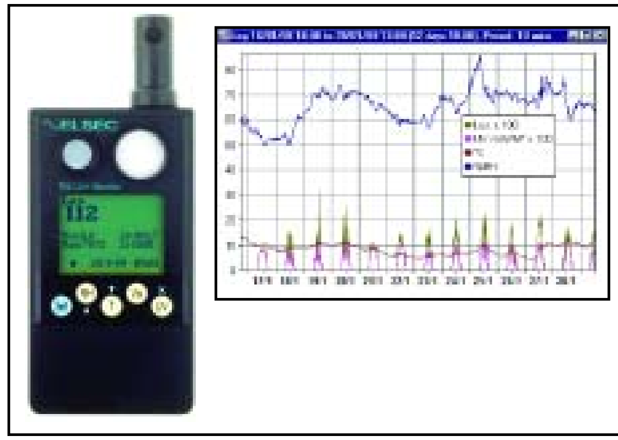

Fig 6. This UV-B meter, Elstec 743, continuously monitors radiation in the 290-400 nm wavelength spectrum. Such meters offer an economical method of assessing the value of UV-B lighting systems. The device also measures relative humidity, ambient temperature and visible light. Display from Elstec meter (inset).

ment of 25-hydroxycholecalciferol is the most accurate assessment of the vitamin D status of an individual. An assay for this metabolite has been used in both captive African grey parrots and wild iguanas. In free-living iguanas, the concentration of 25-hydroxycholecalciferol varies depending on an individual's exposure to UV-B light. The author has already shown that by feeding a diet with adequate vitamin D content to African grey parrots, blood concentrations of both ionized calcium and 25-hydroxycholecalciferol can be significantly increased. The study reported here evaluates the results of UV light exposure on the levels of serum ionised calcium and 25-hydroxycholecalciferol in a group of 40 healthy African grey parrots.

Study

Twenty pairs of mature African grey parrots were kept in a single span building. Each pair was randomly allocated to one of 2 dietary groups either fed formulated diet (Harrison's High Potency Coarse®) or a traditional seed mix (Tidymix®) with no additional supplementation. After 12 months, each bird was clinically examined, and blood samples were collected for measurement of serum ionized calcium and 25-hydroxycholecalciferol concentrations.

The fluorescent lighting tubes in the building in which the birds were housed were then replaced with tubes producing UV-B radiation (Phillips Flutone TLD) (**Figs 5**). Each pair of birds was exposed to UV-B radiation 12 hours daily produce by a pair of 100 cm tubes fixed 80 cm away from each pair's aviary.

Both before and after the additional of supplemental UV-B lighting, an Elstec 743 UV-B meter was used to monitor UV radiation levels to which the birds were exposed. This meter measures the total UV radiation in the 290-400 nm spectrum (**Figs 6a,b**). Although originally designed for museums to assess the amount of UV-B radiation to which antiquities were exposed, the meter appears useful for monitoring the output of UV radiation from lamps sold for use with exotic pets. Meter readings demonstrated that all birds received significantly increased UV-B radiation when exposed to the UV-B fluorescent tubes compared to those without lighting supplementation.

After another 12 months, blood samples were collected and analyzed for serum ionized calcium and 25-hydroxycholecalciferol concentrations

RESULTS - Figs 10 and 11 show the effect of artificial UV-B supplementation on both serum 25-hydroxycholecalciferol and ionized calcium concentrations in all 40 birds, independent of their dietary group. A statistically significant increase in both parameters was recorded after the provision of artificial UV-B lighting in all birds. Previous studies have shown that feeding a formulated diet with increased calcium and vitamin D_3 content relative to seed diets will significantly increase serum levels of ionized calcium and 25-hydroxycholecalciferol. However, in this study, no significant difference in the serum ionized calcium and 25-hydroxycholecalciferol concentrations was noted between the dietary groups after the provision of supplemental UV-B lighting.

After 12 months on their respective diets, prior to UV-B supplementation, the formulated diet-fed group had improved general appearance and plumage relative to the seed-fed birds. However, after the

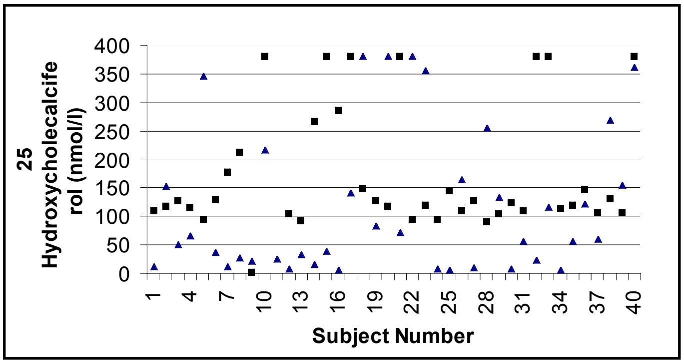

Fig 10. Effect of UV-B supplementation on 25-hydroxycholecalciferol concentrations in African grey parrots.

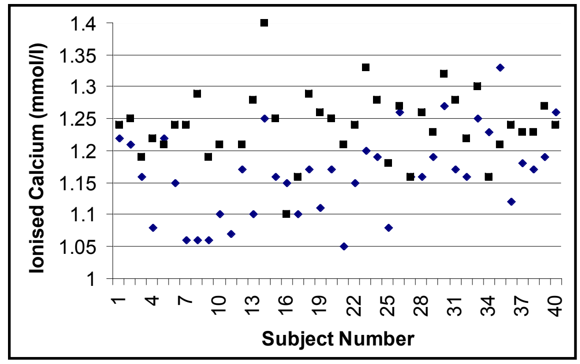

Fig 11. Effect of UV-B supplementation on ionised calcium concentrations.

Ionised calcium without UV-B   Ionised calcium with UV-B

provision of supplemental UV-B lighting, the appearance of the seed-fed group improved such that it was not possible to discern a bird's dietary group based on appearance alone. The author postulates that this was due to improved preening behavior with artificial UV-B lighting supplementation. The breeding performance of the birds also improved significantly when exposed to increased levels of UV-B lighting, independent of the diet fed.

DISCUSSION - This study has shown that the provision of supplementary UV-B lighting significantly increases the serum ionized calcium and 25-hydroxycholecalciferol concentrations in African grey parrots, independent of the calcium or vitamin D_3 content of the diet being fed. It would appear prudent to supply both an adequate diet and UV-B lighting to grey parrots in order to prevent clinical manifestations of hypocalcemia in this species. The author now routinely recommends provision of UV-B lighting to African species. Although the choice of diet did not significantly affect the serum ionized calcium and 25-hydroxycholecalciferol concentrations once adequate UV-B lighting was supplied, offering a good quality diet is still advisable for other reasons.

The author is now evaluating the effects of exposure to UV-B radiation in South American species, which rarely suffer from clinical signs of hypocalcaemia. A similar difference is seen in pygmy tribes where African pygmies are taller than their South American counterparts. One possible explanation offered relates to the reduced level of UV radiation reaching the South American rainforest floor compared with the more open African forests. Several species of South American parrots live below the tree canopy compared with high-dwelling African grey parrots. The author hypothesizes that Amazon and macaw species may have a reduced requirement for vitamin D compared to African grey parrots or may metabolize it in a different manner due to their relatively reduced UV light exposure. This might also explain why macaws are more susceptible to vitamin D toxicity relative to other avian species. Both African and South American species perform geophagy in the wild in order to access necessary minerals and aid the process of detoxification. Analyzing samples of the soil ingested by each respective species would be useful in determining if there is a significant difference in mineral content.

References and Further Reading

1. Bentley PJ: Comparative Vertebrate Endocrinology. Cambridge, UK, Cambridge Univ Press, 1998, pp 269-301.
2. Dacke GC: *In* GC Whittow (ed): Sturkie's Avian Physiology 5th ed. London, UK, Academic Press, 2000, pp 472-485.
3. Edwards HM, Elliot MA, Soonchareming S, Britton WM: Quantitative requirement for cholecalciferol in the absence of ultraviolet light. Poult Sci 73:288-294, 1994.
4. Harcourt-Brown NH: Juvenile osteodystrophy in grey parrots. Vet Rec 152:438-439, 2003.
5. Hochleithner M: Convulsions in African grey parrots in connection with hypocalcemia: Five selected cases. Proc 2nd Euro Symposium Avian Med Surg, 1989, pp 44-52.
6. Hollis BW, Clemens TL, Adams JS: In Favus MJ (ed): Primer on the Metabolic Bone Disease and Disorders of Bone Metabolism. Philadelphia, Lippincott, Williams & Wilkins, 1997.
7. Hurwitz S: Calcium homeostasis in birds. Vitam Horm 45:173-221, 1989.
8. Klasing KC: Comparative Avian Nutrition. New York, CAB Intl, 1998, pp 290-295.
9. Mitchell M: Determination of plasma biochemistries, ionized calcium, vitamin D_3 and hematocrit values in captive green iguanas (*Iguana iguana*). Proc Assoc Reptile Amphib Vet, 2002, pp 87-95.
10. Rosskopf WJ, Woerpel RW, Lane RA: The hypocalcemic syndrome in African greys: An updated clinical viewpoint. Proc Assoc Avian Vet, 1985, pp 129-132.
11. Stanford MD: Measurement of ionized calcium in grey parrots: The effect of diet. Proc Euro Assoc Avian Vet, 2003.
12. Stanford MD: Measurement of ionized calcium in grey parrots (*Psittacus e. erithacus*). Vet Rec, in press, 2004.
13. Stanford MD: Measurement of 25 hydroxycholecalciferol in grey parrots (*Psittacus e. erithacus*). Vet Rec 153:58-61, 2003.
14. Stanford MD: Measurement of 25 hydroxycholecalciferol in grey parrots: The effect of diet. Proc Euro Assoc Avian Vet, 2003.
15. Taylor TG, Dacke CG: Calcium metabolism and its regulation. In Freeman BM (ed): Physiology and Biochemistry of the Domestic Fowl Vol 5. London, UK, Academic Press, 1984, pp 125-170.
16. Tian XQ, Chen, et al: Characterisation of the translocation process of vitamin D_3 from the skin into the circulation. Endocrinology 135(2):655-6121, 1994.